NOTE ON A GLAUCOPHANE SCHIST FROM THE CONANDALE RANGE, QUEENSLAND.

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Last year, on a trip to Queensland to review the field geology of the East Moreton District prior to the publication of my paper dealing with that area, (These Proceedings, 1906, p.73) I went from Woodford, on the Stanley River, across the Conandale Range to the headwaters of the Mary River.

On the 'Postman's Track,' at the foot of the range on the Mary River side, there is a quartz reef bearing a trace of gold running across the track. It intrudes highly metamorphic and foliated schists and phyllites. Close to the reef, and interbedded with the other metamorphic rocks, there is a body of dark, blue-black schist, having a silky lustre and true schistose fracture. This rock struck me at once as being an interesting amphibolite schist, and I accordingly took a specimen. A few hundred yards further along the road, I met with a highly interesting mass of felspar porphyry intruding the metamorphic series. This rock has no relationship with the schists in question, but is closely related to the porphyrites at Point Arkwright and Noosa Head, on the coast. It is, in fact, a granophyric porphyry containing albite, orthoclase, quartz, augite, and hornblende, and belongs, therefore, to the monzonitic series. The structure and composition of this rock bring out its affinities with the Post-Triassic porphyries so strongly that it gives one good reason to believe that most of the granites of the Yabba Ranges, which belong to the same monzonitic class, are of Post-Triassic age.

If most of the granites are Post-Triassic, it is easy to comprehend that rocks as young as Carboniferous (to which age all the East Moreton schistose rocks are referred by Jack) or Devonian (as Gregory terms them) have been foliated and metamorphosed as highly as the Archæan rocks of other parts of the world.

The glaucophane schist from the Conandale Range is a fine-grained, dark schistose rock. In appearance this rock has no resemblance to the Mount Mee glaucophane rocks described by me. Under the microscope it is seen to be tolerably even-grained, and to be laminated in such a way that layers of amphibole crystals alternate with layers of fine granular quartz and felspar. The structure is very like schlieric structure in gabbros. Magnetite is present, generally collected along the division-lines between the layers of hornblende and of colourless minerals.

The amphibole consists of hypidiomorphic grains of a bluish-green glaucophane having the following scheme of pleochroism—

$$\mathfrak{c} \text{ sky-blue} > \mathfrak{b} \text{ greenish} > \mathfrak{a} \text{ yellowish.}$$

The extinction angle is $10°$ ($\mathfrak{c} : c = 10°$) and the mineral is optically positive. In character it is, therefore, allied to both glaucophane and actinolite.

A chemical analysis of this rock was made, and the result is stated below, with the analysis of the glaucophane rock from Mount Mee stated for comparison (*cp.* my paper, *loc. cit.*).

	Glaucophane Schist, Conandale Range.		Glaucophane Rock, Mount Mee.	
		Mol.		Mol.
SiO_2	47·21	0·787	49·98	0·833
Al_2O_3	14·35	0·140	11·95	0·117
Fe_2O_3	3·11	0·019	13·91	0·087
FeO	10·78	}	2·75	}
MnO	0·09	} 0·152	0·13	} 0·041
NiO(CoO)	0·10	}	0·10	}
MgO	6·38	0·159	5·53	0·138
CaO	11·28	0·202	10·54	0·188
Na_2O	2·91	0·047	2·63	0·043
K_2O	0·49	0·005	0·26	0·003
H_2O+	0·32	0·020	1·18	0·067
H_2O-	0·34	—	0·03	—
CO_2	abs.		0·02	
TiO_2	2·20	0·028	0·80	0·010
S	—	—	0·23	0·007
P_2O_5	trace n.d.	—	pres. n.d.	—
	99·56		100·04	

For the sake of being able to compare these two rocks, I calculated their norms, first in terms of such minerals as usually occur in glaucophane schists, next in terms of such minerals as occur in igneous rocks. The chemical symbols for the minerals were taken from Dana's 'Text-Book of Mineralogy.' The following results were obtained :—

1. Glaucophane Schist, Conandale Range.

Glaucophane	32·91 %
Epidote	2·20
Perofskite	3·81
Actinolite	27·49
Anorthite	21·41
Orthoclase	2·78
Omphacite	2·23
Akermannite	2·12
Magnetite	3·78
	98·73
Water	0·64
Total	99·37

The composition of glaucophane was taken as SiO_2, 57·6 %; Al_2O_3, 16·3; FeO, 7·7; Mg, 8·5; and Na_2O, 9·9; and, in the epidote, the ratio of Al_2O_3 to Fe_2O_3 was taken to be 5 : 1 (for formulæ, see Dana, *op cit.*).

2. Glaucophane Rock, Mount Mee.

Glaucophane	28·61
Epidote	47·53
Perofskite	1·36
Chlorite	7·03
Orthoclase	1·67
Quartz	13·91
Pyrites	0·36
Total	100·48

The glaucophane was calculated on the formula Na_2O, Al_2O_3, 2(FeMg)O, $6SiO_2$ with the ratio of Mg to Fe as 2 : 1.

The epidote was assumed to be, as observed in the mode, highly ferriferous; and to contain 0·049 mol. H_2O, 0·178 mol. CaO, 0·087 mol. Fe_2O_3, 0·060 mol. Al_2O_3, and 0·294 mol. SiO_2.

All the MgO (81 mol.), FeO (9 mol.), Al_2O_3 (11 mol.), and H_2O (28 mol.) left, after satisfying the other minerals excepting quartz, was allotted to chlorite, whose composition would be between that of chlinochlore and that of pennine.

	3. Glaucophane Schist, Conandale Range.	4. Glaucophane Rock,† Mt. Mee.
Quartz	nil	9·60
Orthoclase	2·78	1·67
Albite	24·63	22·53
Anorthite	24·46	19·74
Diopside	26·45	25·27
Olivine	11·48	nil
Hypersthene	nil	2·10
Ilmenite	4·26	1·52
Magnetite	4·41	6·50
Hæmatite	nil	9·44
Pyrites	nil	0·36
*Extra CaO for apatite	0·44	
Water	0·66	1·21
	99·57	99·94
	Salfemic.	Salfemic.
Order - .	Gallare.	Order 4. Vaalare.
	Docalcic.	Docalcic.
	Presodic.	Presodic.
	Auvergnose.	

The Mt. Mee glaucophane rock I have already shown to be most likely an altered tuff of the gabbro family. It is associated with massive igneous rock altered to chlorite and amphibolite

* If insufficient P_2O_5 be present, this CaO serves to reduce some of the diopside to olivine.

† I have recalculated the norm of this rock because in my previous calculation I discovered some errors, which, however, do not affect its systematic position.

schists, and more or less rudely stratified rocks having the appearance of altered tuffs.

The Conandale glaucophane schist is associated with perfectly stratified schistose rocks, which have certainly been laid down by the aid of water; but fossils I have never met with in them. This last characteristic, so common with the metamorphic rocks of the East Moreton area, may indicate that these rocks, even when stratified, are primarily of volcanic origin, having been redistributed by water. The chemical composition of the Conandale glaucophane schist, as shown above, is such that it might easily have been derived from a basaltic tuff.

The calculation of the norm of these rocks in terms of glaucophane, epidote, actinolite, chlorite, perofskite, etc., brings the norm of these rocks into very close agreement with the mode.

There is reason to believe that the Mount Mee glaucophane rock, associated as it is with chloritic schists, etc., owes its patches of deep blue colour partly to the incipient alteration of its constituents to chlorites like delessite and chloritoid.

The glaucophane of the Conandale specimen approaches actinolite in character, and is probably either an intermediate variety or a mixture of these hornblendes. This, too, is evident from the norm.